

Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-04	Revision 1
Title: FSTD Modeling and Evaluation Recommendations for Engine and Airframe Icing		Effective Date: December 20, 2011	Page 1 of 13

FSTD Guidance Bulletin 11-04

FSTD Modeling and Evaluation Recommendations for Engine and Airframe Icing

Purpose:

This Guidance Bulletin describes certain recommendations that are currently under FAA review with regard to the modeling of icing conditions in FSTDs. FSTD sponsors are provided these recommendations and the suggested evaluation criteria for developing improved aircraft specific ice accretion models for previously qualified and new FSTDs.

Scope:

This Guidance Bulletin describes certain methods and procedures not currently required by the Code of Federal Regulations. Rulemaking processes in support of recent legislation are, however, under consideration to codify improved FSTD evaluation standards into regulation (14 CFR Part 60). The proposals described herein are provided as voluntary guidance and may or may not be included in any potential rule change. If an applicant chooses to utilize the approach described within this Guidance Bulletin, that applicant must adhere to all methods, procedures, and standards herein. Should an applicant desire to use another means to modify a qualified FSTD, a proposal must be submitted to the National Simulator Program Manager (NSPM) for review and approval prior to implementation as described in § 60.23.

Approval: Harlan G. Sparrow III
National Simulator Program Manager

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-04	Revision 1
Title: FSTD Modeling and Evaluation Recommendations for Engine and Airframe Icing		Effective Date: December 20, 2011	Page 2 of 13

REVISION HISTORY		
Rev	Description of Change	Effective Date
0	Original Draft.	12/19/2011
1	Enhance for clarity.	12/20/2011

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-04	Revision 1
Title: FSTD Modeling and Evaluation Recommendations for Engine and Airframe Icing		Effective Date: December 20, 2011	Page 3 of 13

1. Background and Rulemaking Efforts

Historically, the effects of icing have, in some cases, been simulated by adding weight to the simulated aircraft void of abnormal aerodynamic characteristics, increasing stall speeds, or altering engine performance. Studies of airplane accidents where loss of control (LOC) was attributed to icing suggest that existing FSTD icing models that do not capture additional effects may be inadequate for training. On August 1, 2010, The Airline Safety and Federal Aviation Administration Extension Act of 2010 was passed into law (Public Law #111-216). Section 208(b) of this act required the FAA to convene a multidisciplinary panel to study methods for improving crewmember familiarity and responsiveness to stick pusher systems, icing conditions, microburst and windshear weather events.¹

Recommendations for improved FSTD standards with regard to icing have been proposed by the International Committee on Aviation Training in Extended Envelopes (ICATEE)² and were based upon the standards for engine and airframe icing in the ICAO 9625 Edition 3 document. The proposed standards were further refined by ICATEE as part of an effort by a wide range of subject matter experts on simulator development and evaluation to address loss of control in flight. The material recommended by ICATEE is currently under FAA review for consideration in improving FSTD qualification standards.

2. Proposed FSTD Icing Evaluation and Qualification Criteria:

To date, the ICATEE group has made several recommendations to improve FSTD evaluation standards with regard to training in icing conditions. See Attachment A for a complete description of the proposed changes recommended by the technical expert subcommittees. Attachments B and C contain the subcommittee's proposed amendments to the Part 60 Qualification Performance Standards (QPS) Tables for FSTD minimum requirements and objective testing requirements. Briefly summarizing the content of the attachments:

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-04	Revision 1
Title: FSTD Modeling and Evaluation Recommendations for Engine and Airframe Icing		Effective Date: December 20, 2011	Page 4 of 13

Modeling/Evaluation Considerations:

2.1. Aircraft specific icing effects representing the actual flight dynamics and performance changes should be simulated to include:

2.1.1. Aerodynamic degradation effects of ice accretion (where applicable by simulated aircraft type) including loss of lift, decrease in stall angle of attack, airframe buffeting (if applicable), change in pitching moment, change in control effectiveness and forces, and any overall increase in drag.

2.1.2. There should be the potential to have the aircraft stall before the stall warning systems activate where applicable by aircraft type.

2.2. The operation of ice detection, protection equipment, and associated malfunctions in response to detected ice accretion (either through manual or automatic detection) should be simulated.

2.3. The effects of engine ice ingestion should be simulated.

2.4. Specific aircraft data (where available), OEM engineering simulations, or other analytical methods should be utilized in the development of ice accretion models.

2.5. A Statement of Compliance (SOC) provided by the aircraft OEM, aerodynamic data provider, or other acceptable source stating:

2.5.1. A description of expected aircraft specific recognition cues and degradation effects

2.5.2. A description of the source data and any analytical methods used to develop the ice accretion model and verification testing

Objective Testing Considerations:

2.6. Two tests are required incorporating at least one ice accretion model described in the SOC that demonstrate engine and airframe icing effects.

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-04	Revision 1
Title: FSTD Modeling and Evaluation Recommendations for Engine and Airframe Icing		Effective Date: December 20, 2011	Page 5 of 13

Validation data is not required. The first shall demonstrate the FSTD baseline performance of a full stall and initiation of recovery without icing effects. The second shall demonstrate the aerodynamic effects of ice accretion relative to the baseline test. The NSP recommends overlay abilities of test results. These tests shall be included in the Master Qualification Test Guide (MQTG).

3. Summary and Interim Recommendations:

The NSPM has determined that some FSTDs may lack the fidelity to accurately simulate the aerodynamic and aircraft specific effects of ice accretion. It is understood that most sponsors are already conducting FSTD training in icing conditions based upon less comprehensive icing modeling techniques. Until a final rule is published revising the Part 60 technical FSTD requirements for icing, there are no additional FSTD requirements for sponsors conducting training in icing. Sponsors may therefore continue to use their FSTDs in such training as originally qualified by the NSP and approved by the Training Program Approval Authority (TPAA). In the interim, the NSPM encourages sponsors to review the proposed requirements in this bulletin and assess their FSTDs for potential improvements to their ice accretion models. It is expected that in many cases sponsors will be required to obtain and incorporate additional flight test and/or analytical data to implement an updated icing model in accordance with a revision to the rule.

Sponsors may, at their own discretion, voluntarily modify their FSTDs ahead of any anticipated regulation to include aircraft specific ice accretion modeling as described in this bulletin. In doing so, sponsors must ensure that such modifications are reported to the NSPM in accordance with §60.23 at which time the NSPM may elect to conduct additional FSTD evaluations as determined necessary.

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-04	Revision 1
Title: FSTD Modeling and Evaluation Recommendations for Engine and Airframe Icing		Effective Date: December 20, 2011	Page 6 of 13

Attachment A:

Engine and Airframe Icing Evaluation

1. **Basic Requirements:** This attachment applies to all simulators that are used to satisfy training requirements for engine and airframe icing. New general requirements and objective requirements for simulator qualification have been developed to define aircraft specific icing models that support training objectives for the recognition and recovery from an in-flight ice accretion event.

The qualification of engine and airframe icing consists of the following elements that must be considered when developing ice accretion models for use in training.

- a. Ice accretion models must be developed to account for training the specific skills required for recognition of ice accumulation and execution of the required response.
 - b. Ice accretions models must be developed in a manner to contain aircraft specific recognition cues as determined with aircraft OEM supplied data or other suitable analytical methods.
 - c. At least one qualified ice accretion model must be objectively tested to demonstrate that the model has been implemented correctly and generates the correct cues as necessary for training.
2. **Statement of Compliance:** The required statement of compliance must contain the following information to support qualification as described in the table of general requirements:
 - a. A description of expected aircraft specific recognition cues and degradation effects due to a typical in-flight icing encounter. Typical cues may include loss of lift, decrease in stall angle of attack, change in pitching moment, decrease in control effectiveness, decrease in stall angle of attack, and changes in control forces in addition to any overall increase in drag. This description must be based upon relevant source data, such as aircraft OEM supplied data, accident/incident data, or other acceptable data source. Where a particular airframe has demonstrated vulnerabilities to a specific type of ice accretion (due to accident/incident history) which may require specific training (such as SLD icing, tailplane icing, etc.), ice accretion models must be developed that address the training requirements.

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-04	Revision 1
Title: FSTD Modeling and Evaluation Recommendations for Engine and Airframe Icing		Effective Date: December 20, 2011	Page 7 of 13

- b. A description of the data sources utilized to develop the qualified ice accretion models. Acceptable data sources may be, but are not limited to, flight test data, aircraft OEM engineering simulation data, or other analytical methods based upon established engineering principles.

- 3. Objective Demonstration Test:** The purpose of the objective demonstration test is to demonstrate that the ice accretion models as described in the Statement of Compliance have been implemented correctly and demonstrate the proper cues as defined in the approved data sources. At least one ice accretion model must be selected for testing and included in the Master Qualification Test Guide (MQTG). Two tests are required to demonstrate engine and airframe icing effects. One test will demonstrate the FSTDs baseline performance without icing, and the second test will demonstrate the aerodynamic and engine effects of ice accretion relative to the baseline test.

- a. **Recorded Parameters:** In each of the two required MQTG cases, a time history recording must be made of the following parameters:

- i. Altitude
 - ii. Airspeed
 - iii. Normal Acceleration
 - iv. Engine Power/settings
 - v. Angle of Attack/Pitch attitude
 - vi. Bank Angle
 - vii. Flight control inputs
 - viii. Stall warning and stall buffet onset
 - ix. Other parameters as necessary to demonstrate the effects of ice accretions.

- b. **Demonstration Maneuver:** The FSTD sponsor must select an ice accretion model as identified in the SOC for testing. The selected maneuver must demonstrate the effects of ice accretion at high angles of attack from a trimmed condition through approach to stall and “full” stall as compared to a baseline (no ice build up) test. The ice accretion models must demonstrate the cues necessary to recognize the onset of ice accretion on the airframe, lifting surfaces, and engines and provide representative degradation in performance and handling qualities to the extent that a recovery can be executed. Typical recognition cues that may be present depending upon the simulated aircraft include:

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-04	Revision 1
Title: FSTD Modeling and Evaluation Recommendations for Engine and Airframe Icing		Effective Date: December 20, 2011	Page 8 of 13

- i. Decrease in stall angle of attack
- ii. Increase in stall warning speed
- iii. Increase in stall buffet onset speed
- iv. Changes in pitching moment
- v. Changes in stall buffet characteristics
- vi. Changes in control effectiveness or control forces
- vii. Engine effects (power variation, vibration, etc.)

Test may be conducted by initializing and maintaining a fixed amount of ice accretion throughout the maneuver in order to evaluate the effects.

Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-04	Revision 1
Title: FSTD Modeling and Evaluation Recommendations for Engine and Airframe Icing		Effective Date: December 20, 2011	Page 9 of 13

Attachment B:

Proposed –Minimum Simulator Requirements						
	<<< QPS Requirements >>>	Simulator Levels				< Information >
Number	General Simulator Requirements	A	B	C	D	Notes
2.j.	<p>Engine and Airframe Icing</p> <p>Modeling that includes the effects of icing, where appropriate, on the airframe, aerodynamics, and the engine(s). Icing models should simulate the aerodynamic degradation effects of ice accretion on the airplane lifting surfaces including loss of lift, decrease in stall angle of attack, change in pitching moment, decrease in control effectiveness, and changes in control forces in addition to any overall increase in drag. Aircraft systems (such as the stall protection system) must respond properly to detected ice accretion consistent with the simulated aircraft.</p> <p>Aircraft OEM data or other acceptable analytical methods must be utilized to develop ice accretion models that are representative of the simulated aircraft's performance degradation in a typical in-flight icing encounter.</p> <p>SOC and tests required. See objective testing requirements.</p>			X	X	<p>SOC should be provided describing the effects which provide training in the specific skills required for recognition of icing phenomena and execution of recovery. The SOC should describe the source data and any analytical methods used to develop ice accretion models including verification that these effects have been tested. Advance coordination with the NSPM is recommended well in advance of an FSTD evaluation and QTG submittal.</p> <p>Icing effects simulation models are only required for those airplanes authorized for operations in icing conditions. Icing simulation models should</p>

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-04	Revision 1
Title: FSTD Modeling and Evaluation Recommendations for Engine and Airframe Icing		Effective Date: December 20, 2011	Page 10 of 13

						be developed to provide training in the specific skills required for recognition of ice accumulation and execution of the required response.
--	--	--	--	--	--	--

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-04	Revision 1
Title: FSTD Modeling and Evaluation Recommendations for Engine and Airframe Icing		Effective Date: December 20, 2011	Page 11 of 13

Attachment C:

Proposed –Full Flight Simulator (FFS) Objective Tests									
<<< QPS Requirements >>>								Information	
Test		Tolerance	Flight Conditions	Test Details	Simulator Level				Notes
Number	Title				A	B	C	D	
2.i. (new)	Engine and Airframe Icing Effects Demonstration (Aerodynamic Stall)		Takeoff, Approach, or Landing	<p>Time history of a full stall and initiation of the recovery. Tests are intended to demonstrate representative aerodynamic effects caused by in-flight ice accretion. Flight test validation data is not required.</p> <p>Two tests are required to demonstrate engine and airframe icing effects. One test will demonstrate the FSTDs baseline performance without icing, and the second test will demonstrate the aerodynamic effects of ice accretion relative to the baseline test.</p> <p>The test must utilize the icing model(s) as described in the required Statement of Compliance in Table A1A, Section 2.j. Test must include rationale that</p>			X	X	<p>Tests will be evaluated for representative effects on relevant aerodynamic parameters such as angle of attack, control inputs, and thrust/power settings.</p> <p>Plotted parameters must include:</p> <ul style="list-style-type: none">•Altitude•Airspeed•Normal acceleration•Engine power•Angle of attack•Pitch attitude•Bank angle•Flight control inputs•Stall warning and stall buffet onset

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-04	Revision 1
Title: FSTD Modeling and Evaluation Recommendations for Engine and Airframe Icing		Effective Date: December 20, 2011	Page 12 of 13

Proposed –Full Flight Simulator (FFS) Objective Tests									
<<< QPS Requirements >>>								Information	
Test		Tolerance	Flight Conditions	Test Details	Simulator Level				Notes
Number	Title				A	B	C	D	
				<div>describes the icing effects being demonstrated. Icing effects must include, but are not limited to the following effects as applicable to the particular airplane:</div> <div><div>▪ Decrease in stall angle of attack</div><div>▪ Changes in pitching moment</div><div>▪ Decrease in control effectiveness</div><div>▪ Changes in control forces</div><div>▪ Increase in drag</div><div>▪ Change in stall buffet characteristics and onset.</div><div>▪ Engine effects (power reduction/variation, vibration, etc.)</div></div>					

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-04	Revision 1
Title: FSTD Modeling and Evaluation Recommendations for Engine and Airframe Icing		Effective Date: December 20, 2011	Page 13 of 13

Notes:

¹ The law also requires rulemaking to require Part 121 air carriers to provide flight crewmember training (which may include FSTD training) for stall recognition, avoidance and recovery. Also See NSP Guidance Bulletins for FSTD Qualification for Upset Recovery Training.” and “FSTD Qualification for Enhanced Stall Training” at http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

² Established in 2009 by the Royal Aeronautical Society, ICATEE consists of a broad range of training providers, simulator manufacturers, data providers, regulators, and other research entities.

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/